

as we do cows. One species of red ant does no work for itself, but makes slaves of a black kind, which then do everything for its masters.

Ants also keep a variety of beetles and other insects in their nests. That they have some reason for this seems clear, because they readily attack any unwelcome intruder; but what that reason is we do not yet know. If these insects are to be regarded as the domestic animals of the ants, then we must admit that the ants possess more domestic animals than we do. But on this and many other points connected with ants we require additional information.

The Strepsiptera are a small, but very remarkable group of insects, parasitic on bees and wasps. The larva (Pl. 4, Fig. 8) is very minute, six-legged, and very active; it passes through its transformations within the body of the bee or wasp. The male and female are very dissimilar. The males are minute, very active, short-lived, and excitable, with one pair of very large membranous wings. The females (Pl. 3, Fig. 8), on the contrary, are almost motionless, and shaped very much like a bottle; they never quit the body of the bee, but only thrust out the head of the bottle between the abdominal rings of the bee.

JOHN LUBBOCK

(To be continued.)

### COTOPAXI—THE FIRST ASCENT OF THE GREAT VOLCANO\*

STANDING fifty miles below the equator, and a hundred west of the meridian of Washington, Cotopaxi is at once the most beautiful and the most terrible of volcanoes. From the valley of Quito it appears like a huge truncated cone, in altitude equal to five Vesuviuses piled upon each other, its summit rising 4,000 ft. above the limit of perpetual snow, its sides presenting alternate ridges and gorges ploughed by descending floods of water, and around the base for miles heaps of ruins—boulders 20 ft. square, and volcanic ashes and mud 600 ft. deep. Very seldom does Cotopaxi wake up to intense activity, for as a rule the higher a volcano the less frequent its eruptions. Generally the only signs of life are the deep rumbling thunders and a cloud of smoke lazily issuing from the crater.

On November 27, 1872, Dr. Reiss—a German naturalist, who, with Dr. Stübel, has been exploring the Valley of Quito during the last forty years—set out from Mulolo with ten peones for the south-west point of the crater. Crossing the river Cutuche at Limpiopungo, where the stream cuts through vast deposits of volcanic ashes, he reached the "Ventanillas," a dry and sterile pampa, since the porous earth retains no moisture. Here the ascent of the cone began. Following the triangular ridge that divides the deep defiles of Manzanaguaico and Pucaguaico, and whose apex reaches the snow limit, he crossed subordinate cerros and pampas, which are so many steps in the grand staircase he was ascending. Vegetation now ceased entirely, and the surface was covered with ashes and black sand. In fact, nearly the whole occidental slope of Cotopaxi, between 12,500 and 16,000 ft., presents the aspect of a dismal black desert. Progress was slow, for at every step the foot sank into the sand, which increased in depth with the ascent.

Suddenly a profound chasm, containing fresh, smoking lava, was discovered on the left. This lava-stream was the lower limit of a vast mass, which from the valley appeared like a long black line. At 2 P.M. our traveller reached the point where the two quebradas unite, marked by an immense pile of rocks. Here he encamped for the night at an altitude of 15,179 feet.

An immense stream of lava came down the cone, and

near the place of encampment divided, entering the two quebradas or ravines mentioned. The lava was still warm, clouds of vapour rising along the whole extent of the stream. During the afternoon the thermometer had stood at freezing point; but in the night it fell to twenty-five degrees.

The next day Dr. Reiss attained all his hopes. Cropping out of the lava stream, but mainly disposed along the borders of it, were numerous rough stones, upon which he advanced as on the rounds of a ladder. The greatest width of the lava current before it divided was about 3,000 ft., and the estimated thickness 150 ft. The lava was entirely black and warm in all its course; its temperature being from 68° to 91°, while that of the atmosphere was 32°. This elevated temperature explains the absence of snow on this part of the slope. The gaseous exhalations from the crevices seemed to be nothing more than air mixed with vapour. This is doubtless the lava-stream which flowed in 1854, and which, by melting vast quantities of snow, caused much devastation in the valley by floods. No fissure or accumulation of scorice indicates the source of the lava-stream; but the altitude of the point of departure is 18,700 feet.

At 8.45 he reached the arenal, a deep mass of fine sand stretching upward at an angle of 40°. Over this he must advance, difficult as it was, for on either side were impassable fields of snow and ice. The temperature of the sand was 77°. Another stream of lava was discovered, which must have flowed with great velocity, since, instead of following the inclination of the cone, it had descended diagonally. Only the peaks of Iliniza and Chimborazo in the opposite Cordillera were visible; but above the clouds, towards the south-west, a dense mass of smoke rose perpendicularly to a prodigious height, and then by an east wind was carried off in a horizontal line westward. This came from the furious and ever-active volcano of Sangay, whose top was invisible, but whose activity was manifested in this manner. As the clouds shifted, the diversified valley and its royal mountains were spread out like a map.

It was now 10.15 A.M.; thermometer, 28°. Fumeroles abounded, giving forth sulphurous gas. And now followed a sheet of compact blue ice, inclined from 35° to 40°; but fortunately it was not smooth, but covered with myriads of points or icicles three or four inches high. Scrambling over this, and climbing over and between walls, some of immense size, suddenly Dr. Reiss reached the edge of the crater. He had reached the western part of the southern lip. The crater presented an elliptical form, the major axis lying north and south. The stones which were continually falling in from all sides, but especially from the west side, rolled together as to the bottom of a funnel; there were no signs of a level bottom. The depth, roughly estimated, appeared to be 1,500 ft. The side of the funnel least inclined, and by which alone it is possible to descend, is the south-west; but here are large fumeroles sending forth dense masses of vapour charged with gas, and having a temperature of 156°. Around these fumeroles were masses of sulphur and a deposit of gypsum mixed with chloride of lime. This is of great interest as being the first instance of a chloride being found among the products of the South American volcanoes. Humboldt thought that the absence of hydrochloric acid was a characteristic of the New World volcanoes. The barometer gave 19,660 ft. as the altitude, while the doctor's trigonometrical observations, repeated at various times from independent bases in the valley, had given him 19,496 ft. as the height of the north peak, and 19,427 ft. for the southern. Both results exceed the altitude estimated by other travellers. Humboldt made it 18,880 ft.

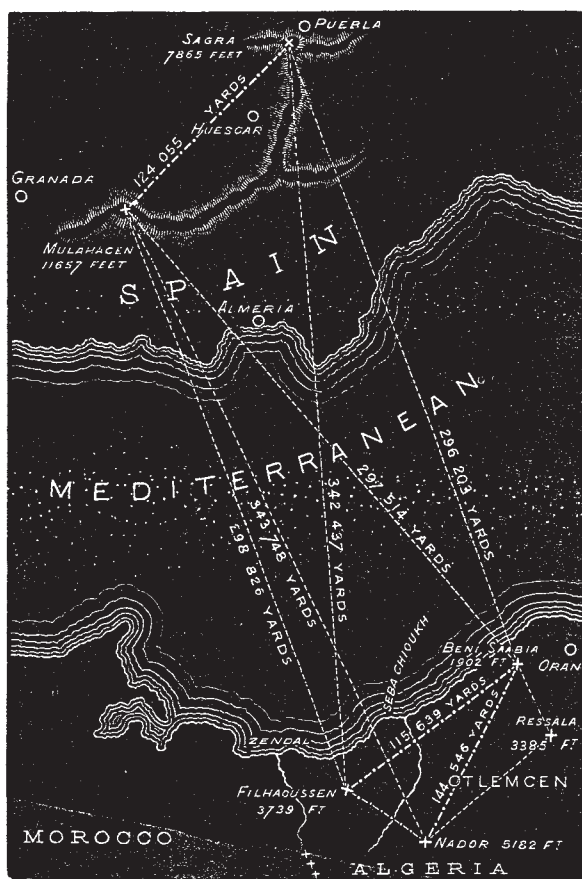
Dr. Reiss left the crater at 1.45 P.M., and reached his encampment at the head of the ridge in three hours and a half, just as a heavy snow-storm began. He says he felt no inconvenience from the rarefaction of the air.

\* Abstract of an article by Mr. James Orton in the *New York Evening Post*, March 12, 1873.

### CAPTAIN PERRIER'S GEODETIC OPERATIONS IN ALGERIA

THE idea of prolonging the French arc of meridian to Sahara by the direct trigonometrical junction of Spain and Algeria, an idea of undoubted scientific value, presented itself to the mind of Captain Perrier when he was collecting the preliminary materials for the survey of Algeria. That survey was begun at the same time as the conquest, in the middle of military operations.

The design was to calculate two great lines conforming to parallels, and transversely cut by three meridians; quadrilaterals would be thus formed, completed by triangles of the first order. Only a linear chain was however drawn, except in the mountainous regions where the operations would have been attended with too many difficulties.



Map showing prolongation of Meridians from Spain to Algeria

This chain, connected with the sea by three excellent bases, would serve the purpose of adjusting and arranging the detailed operations. French geodesy thus measured an arc of latitude cutting the Paris meridian and extending from Morocco to Tunis, with a length of 990 kilometres.

The chain of first-order triangles may be divided into two parts, the first from Blidah to Tunis, measured by Captain Versigny, the other more recent measured by Captain Perrier.

The admirable choice of triangles, stations, and signals is noteworthy. Those signals have been built by the observers themselves, as there were no steeples. The precision obtained is remarkable. In the sum of the three angles of any triangle, the error is about  $3''.12$  (centesimal seconds)\* in M. Versigny's operations (who made use of Gambey's repeating circles); the error is

\* One centesimal second =  $0''.33$  ordinary second,

about  $3''.07$  in M. Perrier's operations, who made use of Brunner's excellent azimuthal circles. In order to measure the bases, the system of M. Porro, an Italian engineer, has been employed, in preference to the old method of Borda, and it has been followed by the best results.

Colonel Levret proved (in 1869), by very exact calculations, that the passage by Gibraltar could be dispensed with, and that it would be possible to communicate between Spain and Algeria, in spite of the immense distance between the two continents. The entire certainty of that possibility has been proved by Captain Perrier, who has pointed out in a precise manner the names and positions of the visible summits and the length of the sides of the new chain.

It was only on October 18, 1868, that he managed to perceive the Spanish shore: he saw it from Seba Chioukh, near the mouth of the Tafna, very distinctly and without the glass. A serrated ridge was to be seen in the distance, toward the north-west, with five prominent summits. The distinctness was so perfect, that he could discern with his naked eyes the different parts of those mountains, those which were in the shade and those illuminated by the sun. He thus measured azimuths with the summit of the Tessala, the zenithal distances of the two highest points of the ridge, and the zenithal distance of the horizon of the sea.

After his return to France, he compared his measurements with the survey of Spain, made by Colonel Cuella, and concluded that he had observed the Mulahacen of the Sierra Nevada, and the peak of Sagra of the Sierra Sagra, the highest points of the Sierras of the Province of Granada.

In Spain the peaks of Sagra can be seen from Mulahacen; those mountains belong to the primordial geodetic chains of the Iberic peninsula. In Africa the points of the quadrilateral (Bem Saabia, Tessala, Filhaoussen, and Nador) are reciprocally visible, and the three last are situated in the primordial chain of Algeria.

With these points, Captain Perrier was enabled to form a chain common to Europe and Africa. Leaving the station of Seba Chioukh as superfluous, as well as the direction of Nador-Sagra as being too close to the horizon of the sea, he delineated that immense pentagon formed by the five summits of Mulahacen, Sagra, Bem Saabia, Filhaoussen, and Nador, every side and diagonal of which, except one, are the directions that are to be observed. He has even calculated and valued in round numbers the length of the sides of this geodetic chain. He has found—

|                             | Metres. |
|-----------------------------|---------|
| Mulahacen-Filhaoussen . . . | 273,400 |
| „ Nador . . .               | 314,500 |
| „ Bem Saabia . . .          | 272,200 |
| Sagra-Filhaoussen . . .     | 313,300 |
| „ Bem Saabia . . .          | 271,000 |

The length of the terrestrial sides are—

|                              | Metres. |
|------------------------------|---------|
| Bem Saabia-Filhaoussen . . . | 109,800 |
| „ Nador . . .                | 104,800 |
| Mulahacen-Sagra . . .        | 113,900 |

With those approximate numbers (and valuing at  $0''.08$  the coefficient of refraction) he has calculated the altitudes of the two Spanish mountains. The measures thus obtained differ little from the real numbers—

|                     | Metres. |
|---------------------|---------|
| Mulahacen . . . . . | 3,994   |
| Sagra . . . . .     | 2,398   |

given by Colonel Cuella, and thus furnish a new verification.

As the geodetic operations are being continued with great activity in Spain and in Algeria, we may hope that in a few years the geodetic bases of Great Britain, of France, Spain, and Algeria, reduced to the same unit of